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ABSTRACT

Research was conducted to improve applicant selection procedures in the Air Force Reserve Officers' Training Corps (AFROTC) scholarship program. The objectives were to document predictive relationships, if any, between student aptitude measures, academic major, institutional selectivity, and eventual completion of the scholarship program. The analysis included records of student performance for all AFROTC participants during FY 71 through FY 75 (N = 23,000). Results indicated that success in the program could be forecast with prior knowledge of: (a) applicant scores on the Air Force Officer Qualifying Test (AFOQT)-OQ composite and (b) the intended academic major (science and engineering versus other). A significant degree of predictive accuracy was achieved for each of the 4-year, 3-year, and 2-year programs. The effects of additional information based on the AFOQT (Pilot and Navigator composites) and institutional selectivity was found to be non-essential for predicting ROTC training outcomes although the usefulness of the rated training composites was again documented for undergraduate pilot and navigator training. Specifications were discussed to developing a dual selection system appropriate for both pre- and post-entry training programs. The implementation of such a system could result in considerable savings given the high costs of attrition typically associated with these programs. (Author)

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AIR FORCE HUMAN RESOURCES LABORATORY

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PREDICTING SUCCESS IN THE AFROTC SCHOLARSHIP PROGRAM

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April 1977
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This final report was submitted by Personnel Research Division, Air Force Human Resources Laboratory, Lackland Air Force Base, Texas 78236, under project 7719, with HQ Air Force Human Resources Laboratory (AFSC), Brooks Air Force Base, Texas 78235. Dr. Nancy Guinn, Personnel Research Division, was the project monitor.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Research was conducted to improve applicant selection procedures in the AFROTC scholarship program. The objectives were to document predictive relationships, if any, between student aptitude measures, academic major, institutional selectivity, and eventual completion of the scholarship program. The analysis included records of student performance for all Air Force Reserve Officers' Training Corps (AFROTC) participants during FY 71 through FY 75 (N = 23,000). Results indicated that success in the program could be forecast with prior knowledge of: (a) applicant scores on the Air Force Officer Qualifying Test (AFOQT)–OQ composite and (b) the intended academic major (science and engineering versus other). A significant degree of predictive accuracy was achieved for each of the 4-year, 3-year, and 2-year programs. The effects of additional information based on the AFOQT (Pilot

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The implementation of such a system could result in considerable savings given the high costs of attrition typically associated with these programs.

PREFACE

This research was conducted under project 7719, Air Force Personnel System Development on Selection, Assignment, Evaluation, Quality Control, Retention, Promotion, and Utilization; task 771902, Exploration of Methods for Increasing the Effectiveness of Personnel Programs. It was initiated in response to RPR 74-28; Development of Improved Selection Techniques for AFROTC Scholarship Awards, originating at AFROTC/ACME. Appreciation is expressed to LtCol Dave Jackson, requirements manager at AFROTC, and to Col Tyree Newton, Chief, Personnel Research Division, for their support during the course of the project. The authors are also grateful for the excellent computational support provided by Mr. Charles Greenway (AFHRL/SM) and his staff.

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PREDICTING SUCCESS IN THE AFROTC SCHOLARSHIP PROGRAM

I. INTRODUCTION

A significant proportion of expenditures in the Air Force Reserve Officer Training Corps (AFROTC) are devoted to the College Scholarship Program, which each year underwrites 6,500 scholarships at an annual cost of approximately 14 million dollars. The magnitude of that investment requires efficient management to avoid unnecessary losses due to attrition, to maintain the quality of graduates, and, in general, to achieve an optimum return for each dollar invested.

The program authorizes scholarships of varying lengths: 4-year, 3-year, and 2-year, each representing the total costs of tuition, fees, and books for the designated enrollment period. Scholarship recipients also receive a monthly stipend of $100. While the annual expenditures per student vary by school, they typically range between $1,200 and $3,000 with an average value of approximately $2,000. Historical data on student attrition in the 4-year program shows that approximately half of the students awarded scholarships failed to complete the program for various academic and other reasons. The attrition rates for the 3- and 2-year programs are generally less (averaging 15% and 12%, respectively) as a result of the higher loss rates associated with the first academic year.

In 1975, Headquarters AFROTC commissioned a study of the scholarship award procedures with a view toward reducing student attrition in the program. This could be accomplished if a certain proportion of "high risk" applicants (i.e., those with little probability of completing training) could be identified prior to actually awarding scholarship benefits. The research was to be conducted in two phases. During Phase I, the basic feasibility of establishing selection criteria was to be examined using historical training records for a 5-year period. The principal objectives were:

1. To document empirical relationships, if any, between individual student aptitudes and probability of successful completion,

2. To examine modifying influences attributable to the type of academic major and to the overall difficulty level of the school, and

3. To determine the potential applicability of the procedure to the 4-, 3-, and 2-year scholarships programs.

During the second phase, selection procedures would be refined using an expanded predictor set which had not yet matured. The purpose of this report is to document the interim findings from Phase I.

II. APPROACH

Subjects

Records of final training disposition for AFROTC participants during FY 71 through FY 75 served as the basis for analysis (N = 22,663). These people were enrolled during that time period at 175 U.S. colleges and universities offering AFROTC programs. Moreover, they had either successfully completed the program or had disenrolled for academic or motivational reasons. The schools are considered representative of all major academic institutions in both the public and private sectors. A distribution of students by program category indicated 10% were 4-year scholarship recipients (N = 2,235), 11% were 3-year scholarship recipients (N = 2,482), and 79% were either 2-year scholarship recipients or non-scholarship contract students enrolled in the advanced AFROTC program (N = 17,946). The latter two categories were combined in the same sample since both were required to sign 2-year contracts contingent on successful completion of the junior and senior years of academic study.

Predictor Variables

Variables for the analysis, unless otherwise indicated, were obtained from historical records of AFROTC participants maintained at the Air Force Human Resources Laboratory.

1. Aptitude Measures: Individual aptitude measures for each participant were obtained from the Air Force Officer Qualifying Test (AFOQT), a group-administered battery designed to evaluate aptitudes which are important for commissioned officer performance and success (Miller, 1968, 1969). The AFOQT consists of 13 subtests, each included in one of several test booklets. The subtests taken in various combinations yield three composite measures in percentile form as shown in Table 1.

Table 1. **Subtests and Composites of the AFOQT**

	Aptitude Composites		
Subtest	Officer Quality	Pilot	Nav-Tech
Quantitative Aptitude	X		X
Verbal Aptitude	X		
Officer Biographical Inventory	X		
Scale Reading			X
Aerial Landmarks			X
General Science			X
Mechanical Information		X	X
Mechanical Principles		X	X
Pilot Biographical Inventory		X	
Aviation Information		X	
Visualization of Maneuvers		X	
Instrument Comprehension		X	
Flight Orientation		X	

a. *The Officer Quality (OQ) Composite*–The OQ composite is primarly a measure of general learning ability and officer quality. It contains measures of verbal and quantitative aptitude, reasoning ability, background knowledge relative to world events, and an inventory of biographical material predictive of officer leadership. Applicants with high Officer Quality scores may be expected to do well in any technical training program having appreciable academic content.

b. *The Pilot Composite*–This is a measure of some of the characteristics necessary for successful completion of pilot training. It includes subtests of mechanical experience, spatial information, and ability to understand and interpret information received from aircraft instruments. Applicants with high scores on this composite have considerably better chances of completing pilot training than those with low scores.

c. *The Navigator-Technical (Nav-Tech) Composite*–The Nav-Tech composite is a measure of abilities to interpret dials and tables, to understand scientific and mathematical principles, and to comprehend mechanical and spatial concepts. It is designed to predict success in training courses requiring these abilities such as navigator training, communications, electronics, maintenance, engineering, and technical intelligence.

2. Institutional Selectivity: This variable was designed to take into account the varying degrees of difficulty presumed to exist between academic institutions hosting AFROTC detachments. It was defined operationally on the basis of the average American College Test (ACT) scores for entering freshmen (American Council on Education, 1968) at each host college or university. In the analysis, all persons enrolled at the same academic institution received identical selectivity scores.

3. Academic Major: As a general index of the effect of academic specialty on probability for success, all cadet academic majors were grouped into two mutually exclusive categories–Science and Engineering (S&E) versus Non-Science and Engineering–as shown in Table 2. These definitions are consistent with the AFROTC practice of identifying certain specialties which are of particular interest in subsequent active duty assignments. These academic specialties are also known as Category III majors.

Table 2. **Academic Specialties Designated Science and Engineering**

Academic Major	Specialties
Science and Engineering	Aeronautical Technology, Aeronautical Engineering, Aerospace Engineering, Astronautical Engineering, Civil Engineering, General Engineering, Industrial Engineering, Mechanical Engineering, Architectural Engineering, Architecture, Electrical Engineering, Electrical Technology, Communications Technology, Computer Sciences, Mathematics, Physics, Space Physics, Meteorology
Non-Science and Engineering	All other academic specialties

Criterion Variable

Training outcome defined on the basis of graduation versus elimination served as the principal criterion for developing the selection system. The elimination category included all types of disenrollment for any reason including academic, motivational, physical, etc.

Analyses

Individual student records were partitioned into three samples defined on the basis of program length: (a) 4-year scholarship recipients, (b) 3-year scholarship recipients, and (c) 2-year scholarship recipients and other contract students. Within each sample, separate regression analyses were conducted to determine the effects of the predictor variables on training outcome (graduated vs. eliminated). The functional relationships initially defined may be expressed as follows:

Training Outcome = f (Aptitude x Institutional Selectivity x Academic Major).

In defining the initial prediction model, a large number of nonlinear and interaction terms were generated from the primary variables to insure relatively complete investigation of all possible relationships. To test for effects attributable to specific predictor measures, several reduced models were also constructed in such a way that various components of the initial prediction model could be systematically eliminated from consideration. Comparisons, based on the statistical accuracy of each model, were performed using the F-ratio and associated probability values (Ward & Jennings, 1973). Complete specifications for the analysis including variable descriptions, prediction models, and specific comparisons performed are given in Appendix A.

III. RESULTS AND DISCUSSION

Basic descriptive data by subsample (Table 3) indicated that people enrolled in the various programs differed in a number of respects. The average OQ score in the 4-year program was 61 versus 68 in the 3-year program and 57 in the 2-year/other program. Scores on the Pilot composite were somewhat more consistent across groups averaging 57, 58, and 55, respectively. The highest average Navigator-Technical score was observed in the 3-year scholarship group (64) with lower averages being noted in the 4-year and 2-year

Table 3. **Means and Standard Deviations of Primary Variables**

Variables	Scholarship Program					
	Four Year (N = 2,235)		Three Year (N = 2,482)		Two Year/Other (N = 17,946)	
	Mean	SD	Mean	SD	Mean	SD
AFOQT – OQ	61.39	23.53	68.42	22.18	56.99	26.93
AFOQT – Pilot	57.23	23.96	58.25	24.82	55.47	27.13
AFOQT – Nav/Tech	58.45	22.46	63.90	22.95	51.94	27.98
S&E vs Non-S&E	.29	.46	.31	.46	.18	.38
Average ACT	23.82	2.26	23.34	2.48	23.05	2.52
AFROTC Completion	.50	.50	.85	.36	.88	.33

cohorts (58 vs. 52). The proportion of science and engineering students in each program was equivalent for both the 4- and 3-year groups at approximately 30%. Only 18% of the 2-year/other scholarship students were designated science and engineering majors. Average ACT was essentially identical for all groups. The overall completion rate for students awarded 4-year scholarships was 50%. Completion rates in the 3- and 2-year programs were 85% and 88%. These data highlight the high rate of attrition normally associated with the freshman academic year.

Results of the regression analysis to determine the unique effects associated with aptitude scores (OQ, Pilot, and Nav-Tech), academic major, and institutional selectivity on program attrition rates are shown in the Appendix (Table A3) and summarized in Table 4. There was a remarkable similarity of results within each of the programs. The full prediction model containing all elements of information available for each student yielded significant predictions of overall success in each program. In subsequent comparisons, the unique effects attributable to the Officer Quality composite and academic major were found to be significant in each of the programs. In none of the samples were Pilot, Nav-Tech scores, or institutional selectivity found to contribute independently to the prediction system.

Table 4. **Summary of Regression Results**

Source of Effect	Significance Levels Within Samples		
	Four Year Scholarships	Three Year Scholarships	Two Year Scholarships/Other
All Effects Combined	**	**	**
Pilot and Nav/Tech Composites	ns	ns	ns
Institutional Selectivity (ACT)	ns	ns	ns
Academic Major (S&E vs Other)	**	**	*
Officer Quality Composite	**	**	**

*Significant at the .05 level.

**Significant at the .01 level.

nsNon-significant.

The final equations identified as predictive of success in each program are shown in Table 5 and plotted in Figures 1 through 3. Looking first at the 4-year scholarship recipients (Figure 1), it will be noted that the probability of successful completion was an ascending function of scores on the Officer Quality composite for both S&E and non-S&E students. The specific function relating OQ to successful completion was nearly linear for the S&E participants ranging from an expected value of .145 for persons scoring at the

Table 5. **Final Regression Equations for Estimating Probability of Success in AFROTC[a]**

Scholarship Program	Academic Major	
	Science and Engineering	Non-Science and Engineering
Four Year	$\hat{Y} = .139964 + .0053467(OQ) - .0000527(OQ^2)$	$\hat{Y} = .154754 + .0130321(OQ) - .0009900(OQ^2)$
Three Year	$\hat{Y} = .428790 + .0105254(OQ) - .0006354(OQ^2)$	$\hat{Y} = .776054 + .0020036(OQ) - .0000882(OQ^2)$
Two Year/Other	$\hat{Y} = .664925 + .0075035(OQ) - .0005112(OQ^2)$	$\hat{Y} = .666661 + .0075663(OQ) - .0005597(OQ^2)$

Note. — For applications where academic major may not be known, less accurate but nonetheless serviceable predictions may be obtained from the following equations based on model 5:

Four-year $\hat{y} = .161308 + .0105650(OQ) - .0070410(OQ^2)$
Three-year $\hat{y} = .688214 + .0043434(OQ) - .0002525(OQ^2)$
Two-year $\hat{y} = .667319 + .0074751(OQ) - .0005396(OQ^2)$

[a]Based on model 3 described in Appendix A (Table 2).

01 percentile level to a high of .600 at the 95th percentile level. For students enrolled in non-S&E curricula, the expected probability of completion increased from .168 at the 01 level to a maximum of .584 at the 65th percentile and decreased slightly thereafter. Once the threshold at 65 was reached, no further improvements were noted in the probability of success among these students.

In the 3-year program (Figure 2) differential probabilities of success were again noted throughout the range of OQ scores regardless of academic major. Differences between categories of academic major were evident to the extent that the probabilities of completion for S&E majors were consistently lower than for non-S&E majors throughout the entire range of OQ scores. That is, at fixed levels on the OQ composite, students enrolled in science and engineering curricula were less likely to complete AFROTC than were students enrolled in non-technical areas. The probability of completion for S&E students increased from approximately .44 to .86 although little further improvement was noted beyond the 75th percentile. For non-S&E students, the proportion completing training increased from .78 at the 01 level to approximately .89 at the 95th percentile.

Among 2-year scholarship and other contract students (Figure 3), there was again an ascending relationship between OQ percentile score and probability of success in the program. Unlike the previous two samples, however, the S&E versus non-S&E distinction seemed to have little bearing on completion once the OQ level was fixed. For both groups, probability of completion increased from .67 to approximately .93 at the 65th percentile and evidenced very little improvement thereafter. The numerical values linking aptitude and academic major to the probability of success in each of the three programs are summarized in Table 6.

The relative efficiency of the selection system identified in these analyses for discriminating successful versus nonsuccessful participants during the FY 71 through FY 75 time period is depicted in Tables 7 through 9. These tables show the frequencies, cumulative frequencies, and cumulative percent of students scoring at each OQ level by academic major and training outcome. Also shown are the actual and predicted graduation rates by OQ level for S&E and non-S&E students. For example, the effect of a simulated requirement that all S&E participants in the 4-year program (Table 7) attain a score of 35 or better on the OQ composite would have been to eliminate 12.8% of the total S&E group (i.e., the cumulative percentage of all S&E students scoring 30 or below). At the same time, the requirement would have eliminated 16.8% of the eliminees versus only 7.9% of subsequent graduates. Expressed somewhat differently, it would also have had the effect of eliminating all applicants whose predicted probability of completion (expressed as a percent) was 29.5% or below.

For non-S&E students, the same requirement would have identified 19.2% of the eliminees as opposed to 12.7% of the graduates. Similar interpretations can be made for the other percentile levels shown in the table. The effects of various simulated requirements on the 3-year program and the 2-year program are shown in Tables 8 and 9, respectively.

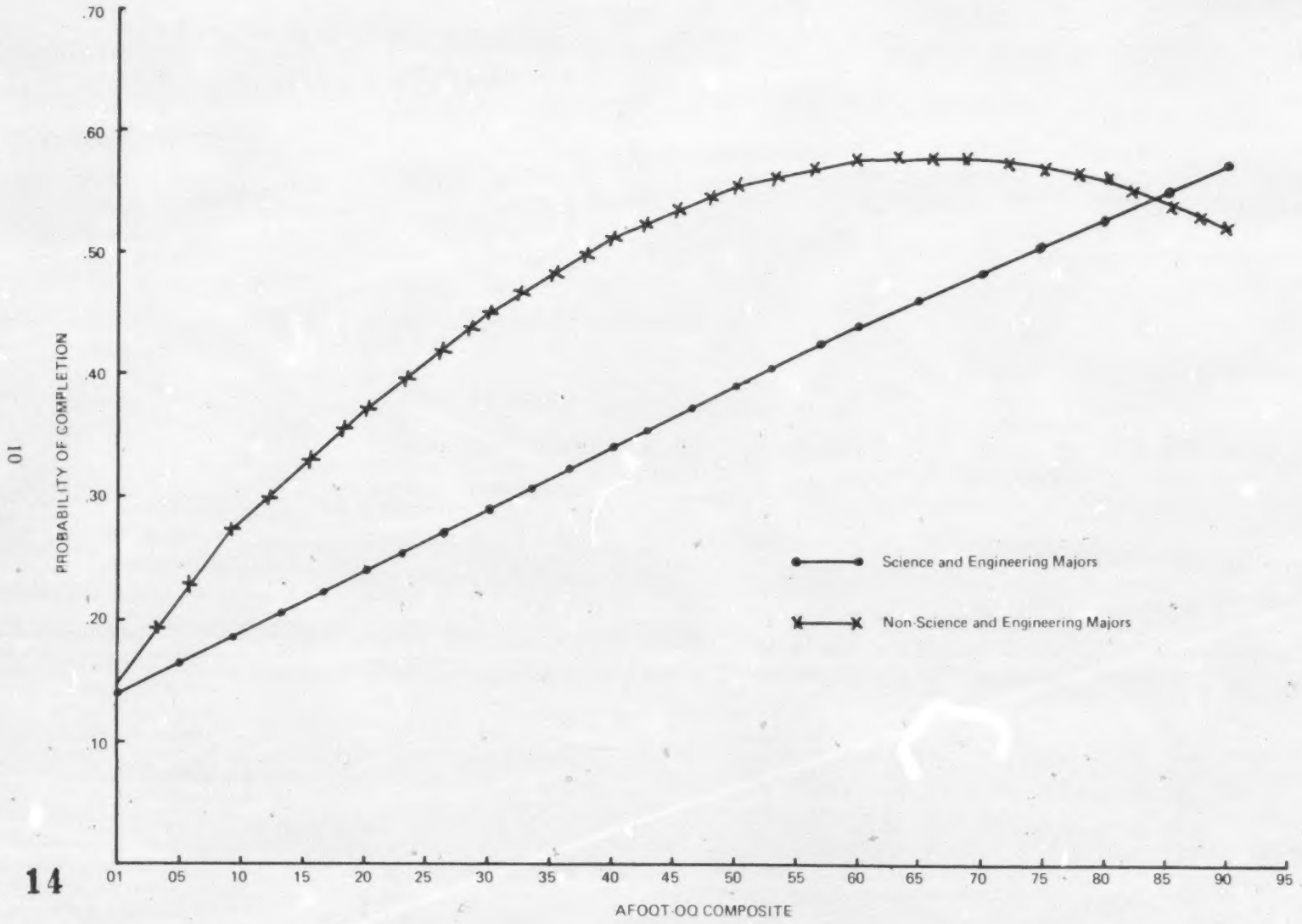

Figure 1. **Success in the four-year scholarship program as a function of aptitude and academic major.**

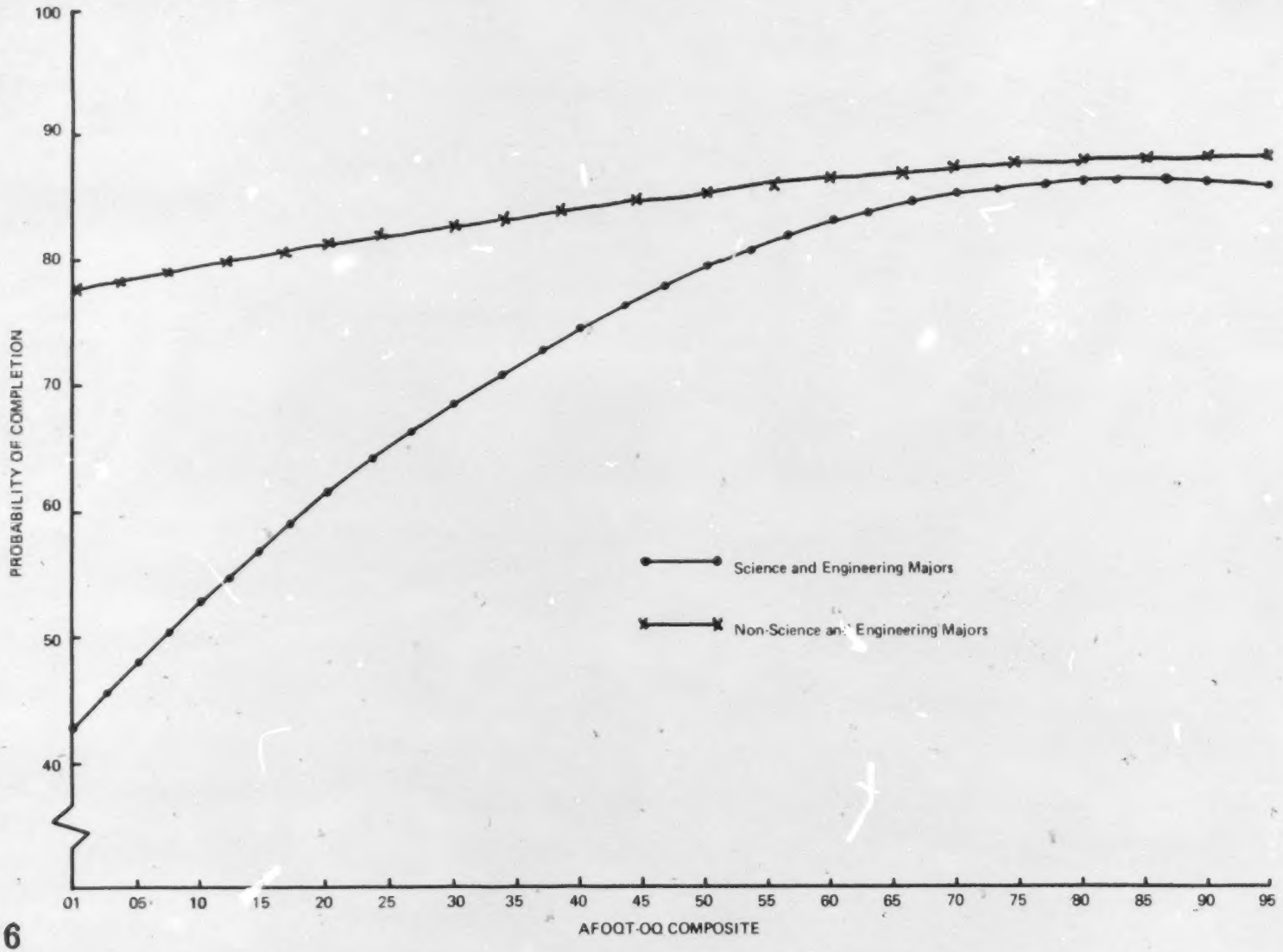

Figure 2. **Success in the three-year scholarship program as a function of aptitude and academic major.**

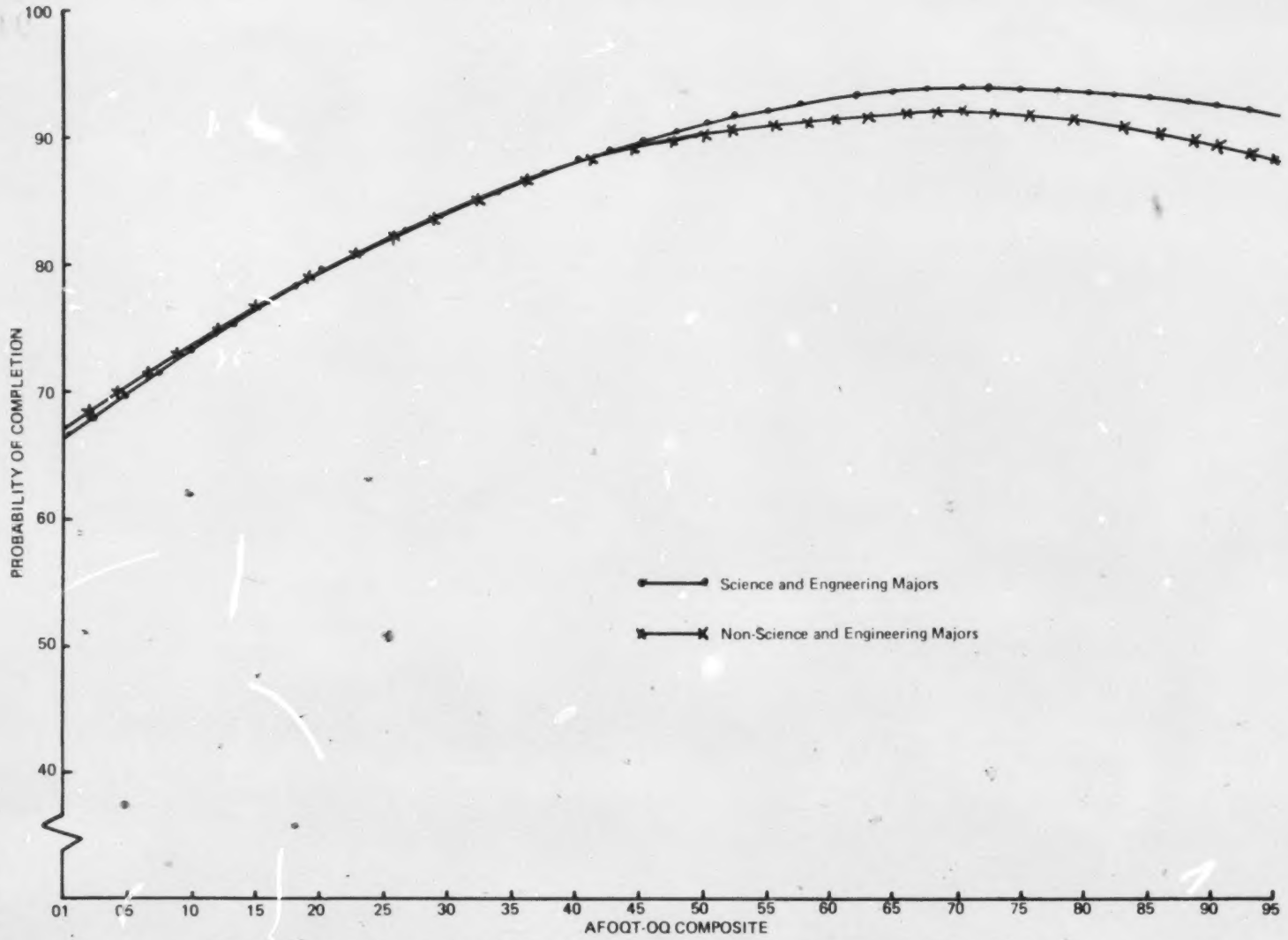

Figure 3. **Success in the two-year scholarship program/POC as a function of aptitude and academic major.**

Table 6. **Probabilities for Successful Completion of AFROTC as a Function of Scholarship Length, Academic Major and Percentile Scores on the AFOQT–Officer Quality Composite**

AFOQT Officer Quality Composite	Four Year Scholarship		Three Year Scholarship		Two Year Scholarship/ Other Contract Students	
	Science and Engineering Majors	Non-Science and Engineering Majors	Science and Engineering Majors	Non-Science and Engineering Majors	Science and Engineering Majors	Non-Science and Engineering Majors
01	.145	.168	.439	.778	.672	.674
05	.167	.218	.480	.786	.701	.703
10	.190	.275	.528	.795	.735	.737
15	.219	.328	.572	.804	.766	.768
20	.240	.376	.614	.813	.795	.796
25	.270	.419	.652	.820	.821	.821
30	.295	.457	.687	.828	.844	.843
35	.320	.490	.719	.835	.865	.863
40	.345	.518	.748	.842	.883	.880
45	.370	.541	.774	.848	.899	.894
50	.394	.559	.796	.854	.912	.905
55	.418	.572	.815	.860	.923	.913
60	.441	.580	.832	.865	.931	.919
65	.465	.584	.844	.869	.937	.922
70	.488	.581	.852	.873	.940	.922
75	.511	.575	.861	.877	.940	.919
80	.533	.564	.864	.880	.938	.914
85	.556	.547	.864	.883	.933	.905
90	.578	.525	.861	.885	.926	.894
95	.600	.499	.855	.887	.916	.880

Table 7. **Frequencies, Cumulative Frequencies and Cumulative Percent of Four-Year Scholarship Recipients Scoring at Each AFOQT–OQ Percentile Level by Academic Major and Training Outcome – FY 71 Through FY 75**

	Science and Engineering Majors											Non-Science and Engineering Majors										
	Graduates			Eliminees			Total			Pct Grads by Level		Graduates			Eliminees			Total			Pct Grads by Level	
AFOQT-OQ Composite	N	Cum N	Cum Pct	N	Cum N	Cum Pct	N	Cum N	Cum Pct	Act	Pred	N	Cum N	Cum Pct	N	Cum N	Cum Pct	N	Cum N	Cum Pct	Act	Pred
01	0	0	00.0	2	2	00.5	2	2	00.3	00.0	14.5	0	0	00.0	4	4	00.5	4	4	00.3	00.0	16.8
05	0	0	00.0	4	6	01.6	4	6	00.9	00.0	16.7	0	0	00.0	5	9	01.2	5	9	00.6	00.0	21.8
10	0	0	00.0	4	10	02.7	4	10	01.5	00.0	19.0	0	0	00.0	12	21	02.8	12	21	01.3	00.0	27.5
15	0	0	00.0	12	22	06.0	12	22	03.4	00.0	21.9	0	0	00.0	23	44	05.8	23	44	02.8	00.0	32.8
20	0	0	00.0	6	28	07.7	6	28	04.3	00.0	24.0	0	0	00.0	15	59	07.8	15	59	03.7	00.0	37.6
25	9	9	03.1	15	43	11.8	24	52	07.9	37.5	27.0	41	41	05.0	47	106	14.1	88	147	09.3	46.6	41.9
30	14	23	07.9	18	61	16.8	32	84	12.8	43.8	29.5	64	105	12.7	39	145	19.2	103	250	15.8	62.1	45.7
35	7	30	10.3	20	81	22.3	27	111	16.9	25.9	32.0	42	147	17.8	48	193	25.6	90	340	21.5	46.7	49.0
40	7	37	12.7	19	100	27.5	26	137	20.9	26.9	34.5	47	194	23.5	42	235	31.2	89	429	27.2	52.8	51.8
45	22	59	20.2	18	118	32.4	40	177	27.0	55.0	37.0	57	251	30.4	40	275	36.5	97	526	33.3	58.8	54.1
50	15	74	25.3	16	134	36.8	31	208	31.7	48.4	39.4	44	295	35.8	41	316	41.9	85	611	38.7	51.8	55.9
55	10	84	28.8	23	157	43.1	33	241	36.7	30.3	41.8	48	343	41.6	43	359	47.6	91	702	44.5	52.7	57.2
60	12	96	32.9	30	187	51.4	42	283	43.1	28.6	44.1	40	383	46.4	47	406	53.8	87	789	50.0	46.0	58.0
65	15	111	38.0	27	214	58.8	42	325	49.5	35.7	46.5	59	442	53.6	43	449	59.3	102	891	56.4	57.8	58.4
70	15	126	43.2	26	240	65.9	41	366	55.8	36.6	48.8	67	509	61.7	59	508	67.4	126	1,017	64.4	53.2	58.1
75	32	158	54.1	27	267	73.4	59	425	64.8	54.2	51.1	71	580	70.3	46	554	73.5	117	1,134	71.8	60.7	57.5
80	24	182	62.3	15	282	77.5	39	464	70.7	61.5	53.3	59	639	77.5	46	600	79.6	105	1,239	78.5	56.2	56.9
85	31	213	72.9	27	309	84.9	58	522	79.6	53.4	55.6	44	683	82.8	48	648	85.9	92	1,331	84.3	47.8	54.7
90	29	242	82.9	20	329	90.4	49	571	87.0	59.2	56.6	67	750	90.9	51	699	92.7	118	1,449	91.8	56.8	52.5
95	50	292	100.0	35	364	100.0	85	656	100.0	58.8	60.0	75	825	100.0	55	754	100.0	130	1,579	100.0	57.7	49.9

Table 8. Frequencies, Cumulative Frequencies and Cumulative Percent of Three-Year Scholarship Recipients Scoring at Each AFOQT–OQ Percentile Level by Academic Major and Training Outcome – FY 71 Through FY 75

	Science and Engineering Majors											Non-Science and Engineering Majors										
	Graduates			Eliminees			Total			Pct Grads by Level		Graduates			Eliminees			Total			Pct Grads by Level	
AFOQT-OQ Composite	N	Cum N	Cum Pct	N	Cum N	Cum Pct	N	Cum N	Cum Pct	Act	Pred	N	Cum N	Cum Pct	N	Cum N	Cum Pct	N	Cum N	Cum Pct	Act	Pred
01	0	0	0	2	2	1.5	2	2	.3	0	43.9	2	2	.1	0	0	0	2	2	.1	100.0	77.8
05	0	0	0	2	4	3.0	2	4	.5	0	48.0	0	2	.1	1	1	.4	1	3	.2	0	78.6
10	0	0	0	1	5	3.8	1	5	.7	0	52.8	0	2	.1	2	3	1.3	2	5	.3	0	79.5
15	0	0	0	1	6	4.5	1	6	.8	0	57.2	2	4	.3	3	6	2.6	5	10	.6	40.0	80.4
20	0	0	0	0	6	4.5	0	6	.8	0	61.4	0	4	.3	0	6	2.6	0	10	.6	0	81.3
25	15	15	2.4	5	11	8.3	20	26	3.4	75.0	65.2	67	71	4.8	12	18	7.7	79	89	5.2	84.8	82.0
30	13	28	4.4	5	16	12.1	18	44	5.8	72.2	68.7	70	141	9.5	11	29	12.3	81	170	9.9	86.4	82.8
35	14	42	6.6	5	21	15.9	19	63	8.2	73.7	71.9	75	216	14.6	12	41	17.4	87	257	15.0	86.2	83.5
40	14	56	8.9	5	26	19.7	19	82	10.7	73.7	74.8	69	285	19.2	10	51	21.7	79	336	19.6	87.3	84.2
45	29	85	13.4	6	32	24.2	35	117	15.3	82.9	77.4	69	354	23.9	14	65	27.7	83	419	24.4	83.1	84.8
50	15	100	15.8	7	39	29.5	22	139	18.2	68.2	79.6	69	423	28.5	19	84	35.7	88	507	29.5	78.4	85.4
55	28	128	20.2	5	44	33.3	33	172	22.5	84.8	81.5	78	501	33.8	12	96	40.9	90	597	34.7	86.7	86.0
60	25	153	24.2	6	50	37.9	31	203	26.6	80.6	83.2	86	587	39.6	18	114	48.5	104	701	40.8	82.7	86.5
65	31	184	29.1	8	58	43.9	39	242	31.7	79.5	84.4	77	664	44.8	15	129	54.9	92	793	46.2	83.7	86.9
70	46	230	36.4	9	67	50.8	55	297	38.9	83.6	85.2	113	777	52.4	23	152	64.7	136	929	54.1	83.1	87.3
75	57	287	45.4	13	80	60.6	70	367	48.0	81.4	86.1	137	914	61.6	15	167	71.1	152	1,081	62.9	90.1	87.7
80	57	344	54.4	10	90	68.2	67	434	56.8	85.1	86.4	107	1,021	68.8	12	179	76.2	119	1,200	69.8	89.9	88.0
85	56	400	63.3	8	98	74.2	64	498	65.2	87.5	86.4	125	1,146	77.3	7	186	79.1	132	1,332	77.5	94.7	88.3
90	77	477	75.5	10	108	81.8	87	585	76.6	88.5	86.1	113	1,259	84.9	16	202	86.0	129	1,461	85.0	87.6	88.5
95	155	632	100.0	24	132	100.0	179	764	100.0	86.6	85.5	224	1,483	100.0	33	235	100.0	257	1,718	100.0	87.2	88.7

Table 9. **Frequencies, Cumulative Frequencies and Cumulative Percent of Two-Year Scholarship Recipients and Other Contract Students at Each AFOQT–OQ Percentile Level by Academic Major and Training Outcome – FY 71 Through FY 75**

	Science and Engineering Majors											Non-Science and Engineering Majors										
	Graduates			Eliminees			Total			Pct Grads by Level		Graduates			Eliminees			Total			Pct Grads by Level	
AFOQT-OQ Composite	N	Cum N	Cum Pct	N	Cum N	Cum Pct	N	Cum N	Cum Pct	Act	Pred	N	Cum N	Cum Pct	N	Cum N	Cum Pct	N	Cum N	Cum Pct	Act	Pred
01	13	13	.4	13	13	4.2	26	26	.8	50.0	67.2	221	221	1.7	146	146	7.6	367	367	2.5	60.2	67.4
05	13	26	.9	11	24	7.7	24	50	1.5	54.2	70.1	192	413	3.2	103	249	12.9	295	662	4.5	65.1	70.3
10	15	41	1.4	6	30	9.6	21	71	2.2	71.4	73.5	201	614	4.8	100	349	18.1	301	963	6.5	66.8	73.7
15	21	62	2.1	14	44	14.0	35	106	3.3	60.0	76.6	269	883	6.9	101	450	23.3	370	1,333	9.1	72.7	76.8
20	37	99	3.4	14	58	18.6	51	157	4.9	72.5	79.5	241	1,124	8.8	87	537	27.8	328	1,661	11.3	73.5	79.6
25	113	212	7.2	18	76	24.4	131	288	8.9	86.3	82.1	824	1,948	15.2	145	682	35.3	969	2,630	17.9	85.0	82.1
30	137	349	11.9	8	84	27.0	145	433	13.4	94.5	84.4	895	2,843	22.2	122	804	41.2	1,017	3,647	24.8	88.0	84.3
35	135	484	16.5	14	98	31.5	149	582	18.0	90.6	86.5	816	3,659	28.6	91	895	46.4	907	4,554	31.0	90.0	86.3
40	90	574	19.6	9	107	34.4	99	681	21.0	90.9	88.3	694	4,353	34.1	92	987	51.1	786	5,340	36.3	88.3	88.0
45	103	677	23.1	12	119	38.3	115	796	24.6	89.6	89.9	692	5,045	39.5	94	1,081	56.0	786	6,126	41.6	88.0	89.4
50	110	787	26.9	22	141	45.3	132	928	28.7	83.3	91.2	741	5,786	45.3	92	1,173	60.8	833	6,959	47.3	89.0	90.5
55	148	935	32.0	18	159	51.1	166	1,094	33.8	89.2	92.3	675	6,461	50.6	94	1,267	65.6	769	7,728	52.5	87.8	91.3
60	158	1,093	37.4	11	170	54.7	169	1,263	39.0	93.5	93.1	696	7,157	56.0	84	1,351	70.0	780	8,508	57.8	89.2	91.9
65	141	1,234	42.2	16	186	59.8	157	1,420	43.9	89.8	93.7	687	7,844	61.4	75	1,426	73.9	762	9,270	63.0	90.2	92.2
70	178	1,412	48.3	16	202	65.0	194	1,614	49.9	91.8	94.0	657	8,501	66.5	78	1,504	77.9	735	10,005	68.0	89.4	92.2
75	228	1,640	56.1	20	222	71.4	248	1,862	57.5	91.9	94.0	744	9,245	72.3	88	1,592	82.6	832	10,837	73.7	89.4	91.9
80	194	1,834	62.7	18	240	77.2	212	2,074	64.1	91.5	93.8	688	9,933	77.7	56	1,648	85.4	744	11,581	78.7	92.5	91.4
85	231	2,065	70.6	17	257	82.6	248	2,322	72.0	93.1	93.3	768	10,701	83.7	83	1,731	89.7	851	12,432	84.5	90.2	90.5
90	334	2,399	82.0	27	284	91.3	361	2,683	83.0	92.5	92.6	939	11,640	91.1	98	1,829	94.8	1,037	13,469	91.6	90.5	89.4
95	526	2,925	100.0	27	311	100.0	553	3,236	100.0	95.1	91.6	1,140	12,780	100.0	101	1,930	100.0	1,241	14,710	100.0	91.9	88.0

Joint Selection for AFROTC and Rated Training Programs

It is common practice, particularly when dealing with scholarship students, to require that certain candidates enter rated training programs (pilot or navigator) upon eventual entry to active duty. Thus, it would be important to consider the feasibility of selecting these students on the basis of their joint probabilities of completing both AFROTC and rated training programs. From previously unpublished analyses of ROTC graduates in the Air Force, it was found that success in pilot and navigator training could be estimated from the Pilot and Navigator-Technical composite scores, respectively, in much the same fashion as was done in the present analysis of AFROTC completion rates. Table 10 presents the empirical findings of this research wherein the probability of completing rated training is estimated from percentile scores on the appropriate composite. These estimates are based on all AFROTC participants in rated training during FY 69 through FY 74 (N = 7,986 pilots and 1,924 navigators). Additional findings suggested that the prediction systems for both AFROTC and rated training were sufficiently independent of one another to permit the computation of joint probabilities of completion as shown in Appendix B.

Table 10. **Probabilities of Successful Completion of Rated Training Programs (UPT/UNT) as a Function of Percentile Scores on the AFOQT Pilot and Nav-Tech Composites[a]**

Undergraduate Pilot Training		Undergraduate Navigator Training	
AFOQT-Pilot Composite	Probability of Completing UPT	AFOQT-Nav/ Tech Composite	Probability of Completing UNT
≤20	.663	≤20	.769
25	.676	25	.782
30	.689	30	.793
35	.703	35	.810
40	.716	40	.823
45	.729	45	.837
50	.742	50	.850
55	.755	55	.864
60	.769	60	.877
65	.782	65	.891
70	.795	70	.904
75	.808	75	.918
80	.821	80	.931
85	.835	85	.945
90	.848	90	.958
95	.861	95	.972

[a]Based on AFROTC participants in rated training programs duing FY 69–FY 74.

Pilot Equation: $\hat{Y}_P = .609595 + .0026514$ (Pilot);
Navigator Equation: $\hat{Y}_N = .714993 + .0027026$ (Nav-Tech)

These tables show the joint probability of completing both the 4-year scholarship program and rated training: Table B1–for use with S&E students expected to enter undergraduate pilot training (UPT); Table B2–for use with non-S&E students scheduled to enter UPT; Table B3–for use with S&E students scheduled to enter undergraduate navigator training (UNT); Table B4–for use with non-S&E students scheduled to enter UNT.

For example, in Table B1, the probability of completing both AFROTC and UPT given OQ = 70 and Pilot = 55 is shown to be .37. Similarly, the probability of completing both training programs given OQ = 40 and Pilot = 95 is .30. Similar tables for application with the 3- and 2-year programs could be constructed by simply cross-multiplying the appropriate columns in Tables 6 and 10.

Some discretion, however, should be exercised in the use of this information in an operational setting because of the implied value judgements associated with these tables. While two people may have the same probability of completion (e.g., OQ = 55; Pilot = 25 vs. OQ = 40; Pilot = 75), it does not necessarily follow that the two candidates have equal value to the Air Force. It might be more desirable (and eventually less costly in terms of attrition) to admit the candidate with OQ = 40; Pilot = 75 in preference to the one with OQ = 55; Pilot = 25 since relatively larger attrition costs are normally associated with the pilot training programs in comparison with the AFROTC scholarship program.

As a general rule for applying these data, the operating agency must consider the relative value to the Air Force associated with each of four joint-training outcomes:

(0_1) Passed AFROTC–passed pilot training
(0_2) Passed AFROTC–failed pilot training
(0_3) Failed AFROTC–would have passed pilot training
(0_4) Failed AFROTC–would have failed pilot training

Once specified, the values may then be combined with the corresponding probabilities to yield the expected value (EV) for a potential candidate:

$$EV = \sum_{j=1}^{4} V(0_j)P(0_j)$$

where $V(0_j)$ is the value of outcome 0_j and $P(0_j)$ is the possibility of outcome 0_j. The $P(0_j)$ for each of the four possible training outcomes is computed as follows:

$P(0_1)$ = Prob of passing AFROTC x Prob of passing UPT/UNT
$P(0_2)$ = Prob of passing AFROTC x (1 - Prob of passing UPT/UNT)
$P(0_3)$ = (1 - Prob of passing AFROTC) x Prob of passing UPT/UNT
$P(0_4)$ = (1 - Prob of passing AFROTC) x (1 - Prob of passing UPT/UNT)

The probability for successful completion of both AFROTC and UPT/UNT, designated $P(0_1)$, has been computed for the 4-year scholarship recipients in Tables B1 through B4 based on the independent estimates of success found in Table 6 (AFROTC) and Table 10 (UPT/UNT). The remaining probabilities designated $P(0_2)$ through $P(0_4)$ would be obtained by substitution in the formulae shown above.[1]

To illustrate the approach, consider a situation where instead of maximizing expected value, program managers want to minimize the expected cost (EC) associated with each decision. The same procedures would be followed except that, among a given set of applicants, the object would be to choose those representing the minimum EC. Further suppose that the average out-of-pocket cost for each attrition in the 4-year scholarship program has been estimated at $3,000 while corresponding costs for each attrition in UPT might be on the order of $17,000. Assuming equal losses of $3,000 for outcomes 0_3 and 0_4 and zero loss for outcome 0_1, then the expected cost of selecting a given candidate would be:

$$EC = \sum_{j=1}^{4} C(0_j)P(0_j)$$

[1] See Gross and Su (1975) or Peterson (1975) for a more complete specification of procedures for incorporating utility estimates into a general selection system.

where the $C(0_j)$ are separate cost estimates for each outcome (0_j): 0, 17,000, 3,000, and 3,000, respectively. Table 11 summarizes the costs and probability values for two hypothetical candidates. Both are prospective science and engineering students designated for eventual entry into UPT. Candidate A obtains OQ = 55; Pilot = 25 while candidate B obtains OQ = 40; Pilot = 75. From Table 6, candidate A is found to have a probability of .418 for completing a 4-year scholarship while B has a probability of completion equal to .345. From Table 10, the probability of completing UPT given Pilot composites of 25 and 75, respectively, are .676 for A and .808 for B. Computing expected costs for each candidate, it will be noted that since A has an EC = 4,120 as compared to 3,140 for B, candidate A would be less desirable even though both candidates had the same estimated probability of completing both AFROTC and UPT ($P[0_1]$ = .28). The use of actual cost factors (or utility values) would, of course, yield different and perhaps more appropriate strategies for joint selection.

Table 11. **Illustration of Expected Cost Computations**

Costs	Candidate A: Science and Engineering Major with OQ = 55; Pilot = 25	Candidate B: Science and Engineering Major with OQ = 40; Pilot = 75
$C(0_1) =$ 0	$P(0_1) =$ AFROTC[a] (.418) x UPT[b] (.676) = .28	$P(0_1) =$ AFROTC[a] (.345) x UPT[b] (.808) = .28
$C(0_2) =$ 17,000	$P(0_2) =$ (.418) x (1 − .676) = .14	$P(0_2) =$ (.345) x (1 − .808) = .07
$C(0_3) =$ 3,000	$P(0_3) =$ (1 − .418) x (.676) = .39	$P(0_3) =$ (1 − .345) x (.808) = .53
$C(0_4) =$ 3,000	$P(0_4) =$ (1 − .418) x (1 − .676) = .19	$P(0_4) =$ (1 − .345) x (1 − .808) = .12
	$EC = \sum_{j=1}^{4} C(0_j)P(0_j) = 4120$	$EC = \sum_{j=1}^{4} C(0_j)P(0_j) = 3140$

[a]Probabilities of completing AFROTC training at given percentile scores on the OQ composite are obtained from Table 6.

[b]Probabilities of completing UPT at given percentile scores on the pilot composite are obtained from Table 10.

IV. SUMMARY AND CONCLUSIONS

The principal conclusions reached as a result of these analyses may be summarized as follows:

1. With prior knowledge of AFOQT-OQ scores and academic major categorized as science and engineering versus other curricula, it is possible to predict the probability of success in AFROTC scholarship programs with a significant degree of accuracy.

2. In general, there were found to be positive relationships between the AFOQT-OQ percentile score and training success in each of the programs included for analysis: 4-year scholarships, 3-year scholarships, and 2-year scholarships/other contract students.

3. Functional relationships between the OQ composite and successful completion of training tended to vary by length of scholarship and by academic major. In general, the effects of aptitude were more pronounced in the 4- and 3-year programs. Within scholarship programs, the relative likelihood of completing training at fixed aptitude levels was found to be lower for students enrolled in science and engineering courses than for those pursuing other academic majors. The evidence does not suggest whether this differential is the result of the relative difficulty of the two academic programs or whether S&E students are less motivated to complete training as compared to non-S&E students. Further research on this issue seems warranted.

4. With one exception, the effects of aptitude on the probability of completing training appeared to be asymptotic. That is, the probability of success in most programs increased with higher aptitude scores up to a certain point, after which, there was little or no increase in the expectancy for completion. Here again, alternative explanations for these effects are plausibe. The aptitude requirements of the various academic programs may be such that additional talent beyond a fixed level may not materially affect the likelihood of success. On the other hand, students with higher aptitudes may be less motivated to complete the AFROTC program. Either one or both of these conditions may be operative. Among 4-year scholarship students pursuing science and engineering degrees, the effects of OQ on probability of completion were more nearly linear throughout the entire range of aptitude scores.

5. Once the effects of the OQ composite and academic major were accounted for, no significant increase in predictive accuracy was obtained using either the Pilot or Navigator composite or the index of institutional selectivity. These findings indicated that predictions based on OQ and academic major would be applicable regardless of scores obtained on the flying training composites and regardless of the degree of selectivity exercised by the host institution.

6. Although not essential for predicting training outcomes in AFROTC, the AFOQT Pilot and Navigator composites were shown to be effective in estimating whether or not an applicant will eventually complete undergraduate pilot and navigator training. Implications of the results for establishing multiple criteria for joint selection into AFROTC and subsequent flying training programs were discussed within a general utility framework.

Based on these analyses, it is recommended that the AFOQT composites and supplementary information on intended academic major be included in the selection system for scholarship awards. Such actions would assist in identifying "high risk" candidates prior to actual award of scholarship benefits. Further efforts to refine the selection system based on analyses of additional predictor variables appear to be warranted.

REFERENCES

American Council on Education. *American universities and colleges* (10th ed.). In O. A. Singletary (Ed.), Washington, DC, 1968.

Gross, A.L., & Su, W Defining a "fair" or "unbiased" selection model: A question of utilities. *Journal of Applied Psychology*, 1975, **60**, 345–351.

Miller, R.E. *Development of officer selection and classification tests – 1968.* AFHRL-TR-68-104, AD-679 989. Lackland AFB, TX: Personnel Research Division, Air Force Human Resources Laboratory, July 1968.

Miller, R.E. *Interpretation and utilization of scores on the Air Force Officer Qualifying Test.* AFHRL-TR-69-103, AD-691 001. Lackland AFB, TX: Personnel Research Division, Air Force Human Resources Laboratory, May 1969.

Peterson, N.S. An expected utility model for "optimal" selection (Iowa Testing Programs Occasional Paper No. 10), 1975.

Ward, J.H., & Jennings, E. *Introduction to linear models.* Englewood Cliffs, NJ: Prentice Hall, 1973.

APPENDIX A: TECHNICAL SPECIFICATIONS FOR REGRESSION ANALYSES

The tables and illustration shown in Appendix A describe the technical aspects of the regression analysis. Table A1 lists predictor variables, Table A2 describes the prediction models that were generated, and Figure A1 shows the sequence of statistical comparisons between models. The five hypotheses tested within each of the 4-, 3-, and 2-year scholarship samples were:

1. *Test for Overall Effects* – In this comparison, the effects of all predictor variables combined were tested for statistical significance. Negative findings in this comparison would have precluded further testing within the sample.

2. *Test for AFOQT Pilot and Nav-Tech Effects* – In this comparison, the effects of the AFOQT flying training composites were tested holding effects of all other variables constant. Negative findings would have indicated that information on the Pilot and Nav-Tech composites provided no unique contributions to predictive accuracy in the context of the remaining variables.

3. *Test for Effects Attributable to Institutional Selectivity (ACT)* – This comparison was designed to test for unique effects associated with differences in the input quality between institutions. Negative findings would have implied that functional relationships between the remaining predictors and training outcome were similar for all levels of institutional selectivity.

4. *Test for Effects due to Academic Major (S&E vs. other)* – In this comparison, the unique effects associated with academic major were tested at fixed levels on the remaining variables.

5. *Test for AFOQT-OQ Effects* – This comparison was designed to test for unique effects of the Officer Quality composite in determining final training outcomes.

As can be noted in Figure A1, the specific models used to test each successive hypothesis were predicated on results from preceding comparisons. The dotted line represents the actual sequence of comparisons based on results within each of the three scholarship samples. That is, Model 3 was found to be the most appropriate for prediction purposes within each sample. Additional details of the statistical procedure may be found in Ward and Jennings (1973).

Table A1. **Predictor Variables**

Variable	Description
1	AFOQT-OQ
2	AFOQT-OQ Squared
3	AFOQT – Pilot
4	AFOQT – Pilot Squared
5	AFOQT – Pilot Availability (1 if score available; 0 otherwise)
6	AFOQT-Nav/Tech
7	AFOQT-Nav/Tech Squared
8	AFOQT-Nav/Tech – Availability (1 if score available; 0 otherwise)
9	Average ACT Composite – varies by institution
10	Average ACT Composite Squared
11	Science and Engineering Academic Major (1 if S&E; 0 otherwise)
12	Non-Science and Engineering Academic Major (1 if non-S&E; 0 otherwise)
13–16	OQ by ACT (Var 1–2 x Var 9–10)
17–20	OQ by Academic Major (Var 1–2 x Var 11–12)
21–24	ACT by Academic Major (Var 9–10 x Var 11–12)
25–32	OQ by ACT by Academic Major (Var 9–10 x Var 11–12)
33–36	Pilot by ACT (Var 3–4 x Var 9–10)
37–40	Pilot by Academic Major (Var 3–4 x Var 9–10 x Var 11–12)
41–48	Pilot by ACT by Academic Major (Var 3–4 x Var 9–10 x Var 11–12)
49–52	Nav by ACT (Var 6–7 x Var 9–10)
53–56	Nav by Academic Major (Var 6–7 x Var 11–12)
57–64	Nav by ACT by Academic Major (Var 6–7 x Var 9–10 x Var 11–12)
65	Training Outcome (1 if graduated; 0 otherwise)

Figure A1. Flow char for model comparisons.

Table A2. Regression Models

Model	Criteria	Number of Independent Predictors	Predictor Variables	Description
0	65	1	Unit Vector (U)	Unit Vector
1	65	44	U + 1–64	OQ + MAJ + ACT + PLT + NAV + (All interactions)
2	65	18	U + 1–32	OQ + MAJ + ACT + (All interactions)
3	65	6	U + 1–2, 11–12, 17–20	OQ + MAJ + (All interactions)
4	65	9	U + 1–2, 9–10, 13–16	OQ + ACT + (All interactions)
5	65	3	U + 1–2	OQ
6	65	2	U + 11–12	MAJ
7	65	3	U + 7–8	ACT
8	65	6	U + 9–10, 11–12, 21–24	MAJ + ACT + (All interactions)
9	65	7	U + 3–5, 6–8	PLT + NAV
10	65	16	U + 1–2, 3–5, 6–8, 11–12, 17–20, 37–40, 53–56	OQ + MAJ + PLT + NAV + (All interactions)
11	65	23	U + 1–2, 3–5, 6–8, 9–10, 13–16, 33–36, 49–52	OQ + ACT + PLT + NAV + (All interactions)
12	65	9	U + 1–2, 3–5, 6–8	OQ + PLT + NAV
13	65	12	U + 11–12, 3–5, 6–8, 37–40, 53–56	MAJ + PLT + NAV + (All interactions)
14	65	17	U + 9–10, 3–5, 6–8, 33–36, 49–52	ACT + PLT + NAV + (All interactions)
15	65	32	U + 9–10, 11–12, 21–24, 33–64	MAJ + ACT + PLT + NAV + (All interactions)

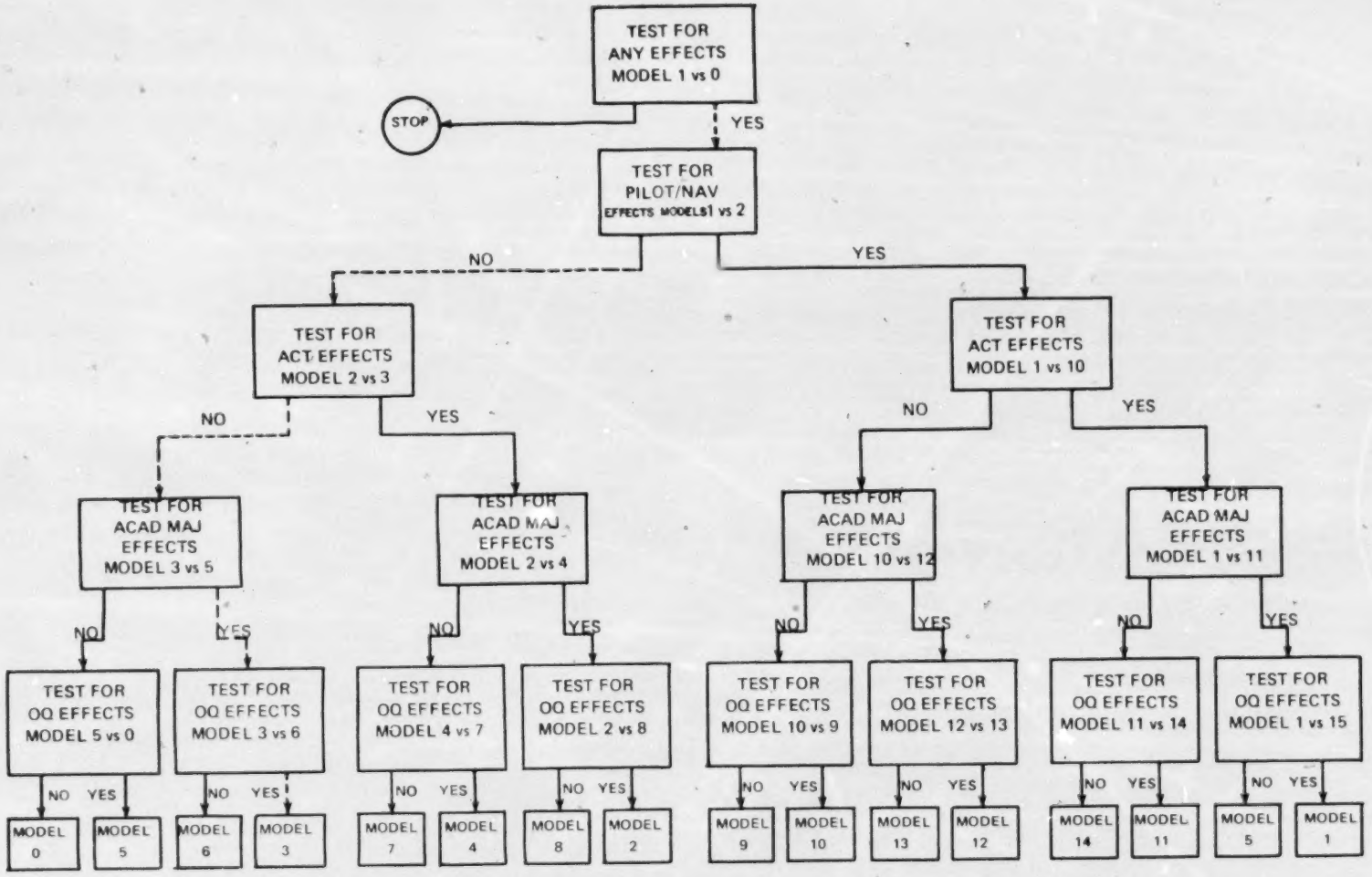
TEST FOR ANY EFFECTS MODEL 1 vs 0
STOP
YES
TEST FOR PILOT/NAV EFFECTS MODELS1 vs 2
NO
YES
TEST FOR ACT EFFECTS MODEL 2 vs 3
TEST FOR ACT EFFECTS MODEL 1 vs 10
NO
YES
NO
YES
TEST FOR ACAD MAJ EFFECTS MODEL 3 vs 5
TEST FOR ACAD MAJ EFFECTS MODEL 2 vs 4
TEST FOR ACAD MAJ EFFECTS MODEL 10 vs 12
TEST FOR ACAD MAJ EFFECTS MODEL 1 vs 11
TEST FOR OQ EFFECTS MODEL 5 vs 0
TEST FOR OQ EFFECTS MODEL 3 vs 6
TEST FOR OQ EFFECTS MODEL 4 vs 7
TEST FOR OQ EFFECTS MODEL 2 vs 8
TEST FOR OQ EFFECTS MODEL 10 vs 9
TEST FOR OQ EFFECTS MODEL 12 vs 13
TEST FOR OQ EFFECTS MODEL 11 vs 14
TEST FOR OQ EFFECTS MODEL 1 vs 15
MODEL 0
MODEL 5
MODEL 6
MODEL 3
MODEL 7
MODEL 4
MODEL 8
MODEL 2
MODEL 9
MODEL 10
MODEL 13
MODEL 12
MODEL 14
MODEL 11
MODEL 5
MODEL 1

Figure A1. **Flow chart for model comparisons.**

Table A3. Summary of F-Tests

Source	Models		Four-Year Scholarships (N = 2,235)					Three-Year Scholarships (N = 2,482)					Two-Year Scholarships/Other Contract (N = 17,946)				
			R^2					R^2					R^2				
	Full	Rest	Full	Rest	d_{f1}	d_{f2}	F	Full	Rest	d_{f1}	d_{f2}	F	Full	Rest	d_{f1}	d_{f2}	F
All Effects Combined	1	0	.0456	.0000	43	2191	2.43**	.0308	.0000	43	2438	1.80**	.0413	.0000	43	17902	17.94**
Pilot and Nav-Tech Composites	1	2	.0456	.0353	26	2191	.91[a]	.0308	.0177	26	2438	1.27[a]	.0413	.0392	26	17902	1.51[a]
Inst. Selectivity (ACT)	2	3	.0353	.0349	12	2217	.07[a]	.0177	.0158	12	2464	.40[a]	.0392	.0383	12	17928	1.40[a]
Academic Major (S&E vs Other)	3	5	.0349	.0234	3	2229	8.85**	.0158	.0083	3	2476	6.29**	.0383	.0378	3	17940	3.10*
Officer Quality Composite	3	6	.0349	.0050	4	2229	17.26**	.0158	.0022	4	2476	8.56**	.0383	.0017	4	17940	170.71**

[a]Non-Significant.

*Significant at the .05 level.

**Significant at the .01 level.

APPENDIX B: JOINT PROBABILITY TABLES FOR ESTIMATING COMPLETION OF BOTH AFROTC (FOUR-YEAR SCHOLARSHIP PROGRAM) AND UPT/UNT BASED ON AFOQT-COMPOSITE SCORES

Table B1. **Probabilities for Successful Completion of Both the Four-Year Scholarship Program and UPT as a Function of Percentile Scores on the AFOQT–OQ and Pilot Composites – Science and Engineering Majors**

AFOQT-OQ Composite	AFOQT–Pilot Composite																
	≤20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	P_1
01	.10	.10	.10	.10	.10	.11	.11	.11	.11	.11	.12	.12	.12	.12	.12	.12	.145
05	.11	.11	.12	.12	.12	.12	.12	.13	.13	.13	.13	.14	.14	.14	.14	.14	.167
10	.13	.13	.13	.13	.14	.14	.14	.14	.15	.15	.15	.15	.16	.16	.16	.16	.190
15	.15	.15	.15	.15	.16	.16	.16	.17	.17	.17	.17	.18	.18	.18	.19	.19	.219
20	.16	.26	.17	.17	.17	.17	.18	.18	.18	.19	.19	.19	.20	.20	.20	.21	.240
25	.18	.28	.19	.19	.19	.20	.20	.20	.21	.21	.21	.22	.22	.23	.23	.23	.270
30	.20	.20	.20	.21	.21	.22	.22	.22	.23	.23	.23	.24	.24	.25	.25	.25	.295
35	.21	.22	.22	.22	.23	.23	.24	.24	.25	.25	.25	.26	.26	.27	.27	.28	.320
40	.23	.23	.24	.24	.25	.25	.26	.26	.27	.27	.27	.28	.28	.29	.29	.30	.345
45	.25	.25	.26	.26	.26	.27	.27	.28	.28	.29	.29	.30	.30	.31	.31	.32	.370
50	.26	.27	.27	.28	.28	.29	.29	.30	.30	.31	.31	.32	.32	.33	.33	.34	.394
55	.28	.28	.29	.29	.30	.30	.31	.32	.32	.33	.33	.34	.34	.35	.35	.36	.418
60	.29	.30	.30	.31	.32	.32	.33	.33	.34	.34	.35	.36	.36	.37	.37	.38	.441
65	.31	.31	.32	.33	.33	.34	.35	.35	.36	.36	.37	.38	.38	.39	.39	.40	.465
70	.32	.33	.34	.34	.35	.36	.36	.37	.38	.38	.39	.39	.40	.41	.41	.42	.488
75	.34	.35	.35	.36	.37	.37	.38	.39	.39	.40	.41	.41	.42	.43	.43	.44	.511
80	.35	.36	.37	.37	.38	.39	.40	.40	.41	.42	.42	.43	.44	.44	.45	.46	.533
85	.37	.38	.38	.39	.40	.41	.41	.42	.43	.43	.44	.45	.46	.46	.47	.48	.556
90	.38	.39	.40	.41	.41	.42	.43	.44	.44	.45	.46	.47	.47	.48	.49	.50	.578
95	.40	.41	.41	.42	.43	.44	.45	.45	.46	.47	.48	.48	.49	.50	.51	.52	.600
P_2	.663	.676	.689	.703	.716	.729	.742	.755	.769	.782	.795	.808	.821	.835	.848	.861	

P_1: Marginal probability of completing AFROTC at given OQ percentile scores.

P_2: Marginal probability of completing UPT at given pilot percentile scores.

Table B2. **Probabilities for Successful Completion of Both the Four-Year Scholarship Program and UPT as a Function of Percentile Scores on the AFOQT–OQ and Pilot Composites–Non-Science and Engineering Majors**

AFOQT-OQ Composite	AFOQT–Pilot Composite																
	≤20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	P_1
01	.11	.11	.12	.12	.12	.12	.12	.13	.13	.13	.13	.14	.14	.14	.14	.14	.168
05	.14	.15	.15	.15	.16	.16	.16	.16	.17	.17	.17	.18	.18	.18	.18	.19	.218
10	.18	.19	.19	.19	.20	.20	.20	.21	.21	.21	.22	.22	.23	.23	.23	.24	.275
15	.22	.22	.23	.23	.23	.24	.24	.25	.25	.26	.26	.27	.27	.27	.28	.28	.328
20	.25	.25	.26	.26	.27	.27	.28	.28	.29	.29	.30	.30	.31	.31	.32	.32	.376
25	.28	.28	.29	.29	.30	.31	.31	.32	.32	.33	.33	.34	.34	.35	.36	.36	.419
30	.30	.31	.32	.32	.33	.33	.34	.35	.35	.36	.36	.37	.38	.38	.39	.39	.457
35	.32	.33	.34	.34	.35	.36	.36	.37	.38	.38	.39	.40	.40	.41	.42	.42	.490
40	.34	.35	.36	.36	.37	.38	.38	.39	.40	.40	.41	.42	.43	.43	.44	.45	.518
45	.36	.37	.37	.38	.39	.39	.40	.41	.42	.42	.43	.44	.44	.45	.46	.47	.541
50	.37	.38	.39	.39	.40	.41	.41	.42	.43	.44	.44	.45	.46	.47	.47	.48	.559
55	.38	.39	.39	.40	.41	.42	.42	.43	.44	.45	.45	.46	.47	.48	.48	.49	.572
60	.38	.39	.40	.41	.42	.42	.43	.44	.45	.45	.46	.47	.48	.48	.49	.50	.580
65	.39	.39	.40	.41	.42	.43	.43	.44	.45	.46	.46	.47	.48	.49	.50	.50	.584
70	.39	.39	.40	.41	.42	.42	.43	.44	.45	.45	.46	.47	.48	.48	.49	.50	.581
75	.38	.39	.40	.40	.41	.42	.43	.43	.44	.45	.46	.46	.47	.48	.49	.50	.575
80	.37	.38	.39	.40	.40	.41	.42	.43	.43	.44	.45	.46	.46	.47	.48	.49	.564
85	.36	.37	.38	.38	.39	.40	.41	.41	.42	.43	.43	.44	.45	.46	.46	.47	.547
90	.35	.36	.36	.37	.38	.38	.39	.40	.40	.41	.42	.42	.43	.44	.45	.45	.525
95	.33	.34	.34	.35	.36	.36	.37	.38	.38	.39	.40	.40	.41	.42	.42	.43	.499
P_2	.663	.676	.689	.703	.716	.729	.742	.755	.769	.782	.795	.808	.821	.835	.848	.861	

P_1: Marginal probability of completing AFROTC at given OQ percentile scores.

P_2: Marginal probability of completing UPT at given pilot percentile scores.

Table B3. **Probabilities for Successful Completion of Both the Four-Year Scholarship Program and UNT as a Function of Percentile Scores on the AFOQT–OQ and Nav-Tech Composites (Science and Engineering Majors)**

AFOQT-OQ Composite	AFOQT Nav-Tech Composite																
	<20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	P_1
01	.11	.11	.12	.12	.12	.12	.12	.12	.13	.13	.13	.13	.13	.14	.14	.14	.145
05	.13	.13	.13	.14	.14	.14	.14	.14	.15	.15	.15	.15	.16	.16	.16	.16	.167
10	.15	.15	.15	.15	.16	.16	.16	.16	.17	.17	.17	.17	.18	.18	.18	.18	.190
15	.17	.17	.17	.18	.18	.18	.19	.19	.19	.20	.20	.20	.20	.21	.21	.21	.219
20	.18	.19	.19	.19	.20	.20	.20	.21	.21	.21	.22	.22	.22	.23	.23	.23	.240
25	.21	.21	.21	.22	.22	.23	.23	.23	.24	.24	.24	.25	.25	.26	.26	.26	.270
30	.23	.23	.23	.24	.24	.25	.25	.25	.26	.26	.27	.27	.27	.28	.28	.29	.295
35	.25	.25	.25	.26	.26	.27	.27	.28	.28	.29	.29	.29	.30	.30	.31	.31	.320
40	.27	.27	.27	.28	.28	.29	.29	.30	.30	.31	.31	.32	.32	.33	.33	.34	.345
45	.28	.29	.29	.30	.30	.31	.31	.32	.32	.33	.33	.34	.34	.35	.35	.36	.370
50	.30	.31	.31	.32	.32	.33	.33	.34	.35	.35	.36	.36	.37	.37	.38	.38	.394
55	.32	.33	.33	.34	.34	.35	.36	.37	.36	.37	.38	.38	.39	.39	.40	.41	.418
60	.34	.35	.35	.36	.36	.37	.37	.38	.39	.39	.40	.40	.41	.42	.42	.43	.441
65	.36	.36	.37	.38	.38	.39	.40	.40	.41	.41	.42	.43	.43	.44	.45	.45	.465
70	.38	.38	.39	.40	.40	.41	.41	.42	.43	.43	.44	.45	.45	.46	.47	.47	.488
75	.39	.40	.41	.41	.42	.43	.43	.44	.45	.46	.46	.47	.48	.48	.49	.50	.511
80	.41	.42	.42	.43	.44	.45	.45	.46	.47	.47	.48	.49	.50	.50	.51	.52	.533
85	.43	.44	.44	.45	.46	.47	.47	.48	.49	.50	.50	.51	.52	.53	.53	.54	.556
90	.44	.45	.46	.47	.48	.48	.49	.50	.51	.51	.52	.53	.54	.55	.55	.56	.578
95	.51	.51	.52	.52	.53	.53	.54	.54	.55	.55	.56	.56	.57	.57	.58	.58	.600
P_2	.769	.782	.793	.810	.823	.837	.850	.864	.877	.891	.904	.918	.931	.945	.958	.972	

P_1: Marginal probability of completing AFROTC at given OQ percentile scores.
P_2: Marginal Probability of completing UNT at given Nav-Tech percentile.

Table B4. **Probabilities for Successful Completion of Both the Four-Year Scholarship Program and UNT as a Function of Percentile Scores on the AFOQT–OQ and Nav-Tech Composites (Non-Science and Engineering Majors)**

AFOQT-OQ Composite	AFOQT Nav-Tech Composite																
	<20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	P_1
01	.13	.13	.13	.14	.14	.14	.14	.15	.15	.15	.15	.15	.16	.16	.16	.18	.168
05	.17	.17	.17	.18	.18	.18	.19	.19	.19	.19	.20	.20	.20	.21	.21	.21	.218
10	.21	.22	.22	.22	.23	.23	.23	.24	.24	.24	.25	.25	.26	.26	.26	.27	.275
15	.25	.26	.26	.27	.27	.27	.28	.28	.29	.29	.30	.30	.31	.31	.31	.32	.328
20	.29	.29	.30	.30	.31	.31	.32	.32	.33	.33	.34	.35	.35	.36	.36	.37	.376
25	.32	.33	.33	.34	.34	.35	.36	.36	.37	.37	.38	.38	.39	.40	.40	.41	.419
30	.35	.36	.36	.37	.38	.38	.39	.39	.40	.41	.41	.42	.43	.43	.44	.44	.457
35	.38	.38	.39	.40	.40	.41	.42	.42	.43	.44	.44	.45	.46	.46	.47	.48	.490
40	.40	.41	.41	.42	.43	.43	.44	.45	.45	.46	.47	.48	.48	.49	.50	.50	.518
45	.42	.42	.43	.44	.45	.45	.46	.47	.47	.48	.49	.50	.50	.51	.52	.53	.541
50	.43	.44	.44	.45	.46	.47	.48	.48	.49	.50	.51	.51	.52	.53	.54	.54	.559
55	.44	.45	.46	.46	.47	.48	.49	.49	.50	.51	.52	.53	.53	.54	.55	.56	.572
60	.45	.45	.46	.47	.48	.49	.49	.50	.51	.52	.52	.53	.54	.55	.56	.56	.580
65	.45	.46	.46	.47	.48	.49	.50	.50	.51	.52	.53	.54	.54	.55	.56	.57	.584
70	.45	.45	.46	.47	.48	.49	.49	.50	.51	.52	.53	.53	.54	.55	.56	.56	.581
75	.44	.45	.46	.47	.47	.48	.49	.50	.50	.51	.52	.53	.54	.54	.55	.56	.575
80	.43	.44	.45	.46	.46	.47	.48	.49	.49	.50	.51	.52	.53	.53	.54	.55	.564
85	.42	.43	.44	.44	.45	.46	.47	.47	.48	.49	.49	.50	.51	.52	.52	.53	.547
90	.40	.41	.42	.43	.43	.44	.45	.45	.46	.47	.47	.48	.49	.50	.50	.51	.525
95	.38	.39	.40	.40	.41	.42	.42	.43	.44	.44	.45	.46	.46	.47	.48	.49	.499
P_2	.769	.782	.793	.810	.823	.837	.850	.864	.877	.891	.904	.918	.931	.945	.958	.972	

P_1: Marginal probability of completing AFROTC at given OQ percentile scores.
P_2: Marginal probability of completing UNT at given Nav-Tech percentile scores.

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